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THE FLYING WINDMILL

By LESTER D. WOODFORD, I.E.-M.E. 2

IF YOU have been close to aeronautical activity during the past year you may have caught a glimpse of an autogiro. If you haven't, just read the Sunday papers. "Flying Windmills" have knocked the bathing beauties off the first page of every rotogravure section in the country.

What a bus! It makes a noise like an airplane, it looks something like an airplane, and for all practical purposes, it is an airplane, but it does things in the great open spaces that would make any airplane in the world turn up its tailskid and hike for home.

It has done things in the air that Al Williams couldn't equal in the best bus in the navy. It has turned tricks that Jimmie Doolittle would have flubbed in the army's safest crate.

Crazy, am I? Not at all. Just seat yourself in the shade of the hangar where you won't be in the way of the grease monkeys and listen to my yarn of this sky-riding gadget that allows us amateur stick-pushers to make monkeys out of the demigods and godlings of aviation.

America first saw the autogiro at the Cleveland Air Races in 1929. It was a bad day for flying with wind and dust and sun. Crowds pressed the edge of the field. Ships leaned their tails in the dirt, while pilots waited for the flag that would send them up to compete in the spot-landing contest. The target was a white circle in the center of the tarmac.

One of those ships looked like a pilot's conception of a nightmare. Below the neck, it was orthodox and regulation. A metal prop, radial engine, and fat airplane fuselage gave it a conventional appearance. Above the neck, well, you've got to use your imagination.

Projecting up over the front cockpit were three four-foot lengths of metal tubing that came together above at a point, pylon-like. On this point rested what appeared to be a four-bladed windmill with fallen arches. Actually! Horny-handed mail pilots took one look and sent mechanics galloping for aspirin. Children ran screaming to their mothers. Women saw it and fainted. That was the way the autogiro looked to them.

But two air-wise men believed in it—Harold Pitcairn, the fellow who brought it to America, and Juan de la Cierva, its inventor and pilot.

Take a look at the latter. Roly-poly, fat-jowled, high-browed, he packed more mathematics in his dome than you can find in a carload of calculating machines.

A Spaniard and a Spanish airplane, to those hard guys

The autogiro has now definitely taken its place in aviation as a new type of airplane. At the present time three separate companies are licensed to build the "flying windmills" in America.

The holder of the American patent rights is the Autogiro Company of America, to whom we are indebted for the illustrations in this article and on the cover.

—The Editor

at the air races, was about as sensible as a Swiss inventing a battleship. So the hard guys snorted, took off and tried to set their crates down on the white circles. Some came fairly close—oh, about thirty or forty yards. Then the starter beckoned to Cierva. The announcer saw the signal and turned to his loud speaker with a grin. Things were dull and this was the spot for a gag.

"Ladeez and gen'mun," he cracked, "the autogiro will now take off—if it can."

The stands howled.

Cierva hit the gun and the winged nightmare rolled across the field. As it went, the big windmill spun faster and faster, losing the wilted appearance that had distinguished it at rest. The mob gasped and leaned hard against benchbacks.

After a thirty-yard run, the autogiro was off. Off and climbing.

"Holy mackerel, he'll spin in!" gritted a hard guy.

The autogiro climbed on. Cierva knew his plane. Coming back, he cut the gun and floated along. Slower and slower. A light headwind held him back still more. For a minute, he hovered almost stationary over the field. Not a syllable was whispered. Any other ship would have crashed. He dropped very slowly, apparently under perfect control. A hundred feet up, he lowered the nose and slid toward the landing circle. Gliding, advancing, he sank until his trucks were six feet off the ground. Stick back, then. The tail came down and the skid jabbed the gravel in the center of the target. She bounced a little and came to rest after a five-foot run. A bull's-eye!

And that was the introduction two years ago of the autogiro in America. Since then it has been redesigned and improved until the present ship is as nice a job as you could ask for.

But first let's get a look at the great engineer, Juan de la Cierva—there is a name for you—who got his start flying gliders when he was a boy, like many of the world's famous aviators. But that didn't satisfy Cierva, so he went to work on an airplane.

In 1918 the Spanish government asked him to build a military bomber. He did, a three-motor bus which flew so well that even the King, who financed it, was satisfied. The pilot who was given the job of pushing her around the sky became over-confident of the ease of handling her and so it happened that one fine day while taking off he tried to lift himself by his own bootstraps, with the usual result. He had to ride "shank's mare" home.

This accident taught Señor Cierva two things: first, that airplanes are fundamentally unstable; and, second, that pilots are liable to make mistakes. So he set to work at designing a ship that would be as safe as the bed you sleep in. In fact, it has proven safer, for people have died in bed but no one as yet has been killed in an autogiro.

No one knows where he got the notion of the flying windmill. Or how he was able to sprinkle salt on its tail and make it work. But he did. In 1922, his first life-size machine was rolled out on a Spanish airdrome and started. It promptly turned over on its side and expired. After a year of trying to figure it out, he repeated the experiment. This new bus shook like a soak with the D.T.'s, threatened to rise, and then died with a long, sweet shudder.

More work, more figures, more pains, and then came the year 1923. Juan de la Cierva sat in his pit and watched the windmill of a redesigned model spin over his head. Five minutes later he was in the air. Success at last!

Or so it seemed until he tried to interest people in his notion. Oh, some of them were half-heartedly enthusiastic, but that was all. Why? Because the world was mad about speed. Wartime crates managed to hit over 120 miles per hour. The autogiro limped along at seventy or eighty top. Government heads told Cierva that his brain child was a good idea from a scientific point of view, but was just so much wet wash as far as they were concerned.

Finally, though, the British government became interested enough to order a couple of machines. That helped matters and furnished materials for more experiments. The ships he built in Britain were a complete success.

Then he met Harold Pitcairn of Philadelphia, and a bargain was sealed that brought the autogiro to the United States. For a while, the old bugaboo hampered them. Speed, speed, speed! Fliers demanded it. So Pitcairn engineering forces went to work under Cierva's direction. Gradually wrinkles were ironed out; gradually experimental models became faster.

Let's take a look at her dimensions. Height, fourteen feet; span of rotor, forty-eight feet; width of rotor blades at tips, two feet; length, twenty-four feet and six inches; weight, loaded, 2850 pounds; pay load, 600 pounds; span of stub wing at bottom of fuselage, fourteen feet.

Nothing sensational about those figures, but listen to this: climb, 1700 feet per minute; take-off speed, twenty-five m.p.h.; landing speed, zero; slow flying speed without loss of altitude, twenty-two m.p.h. There is spectacular stuff. Quick take-off and slow landing speeds. The best aeronautical brains have been trying to accomplish it for years.

More figures: service ceiling, 17,000 feet; absolute ceiling 20,000 feet; motor, Wright J6-300 h.p.; gas capacity, 39 gallons; range 300 miles. Angle of climb, twenty degrees at thirty-five miles per hour. High speed 120-125 m.p.h.; cruising speed, 95-100 m.p.h.

There's no kick in measuring a bus on the ground, so let's hop her. You ride the front pit and I'll take the

rear. Together, we'll take her up and I'll give you a few minutes of dual.

All set? We're ready to go. I pull back the lever that meshes the gears between engine and rotor, slowly at first because the rotor vanes are fairly heavy and a sudden jerk will strip the clutch. It turns, like a huge electric fan to which the current is just applied. Fine! The gears are engaged and I lock the lever back.

Now to accelerate the rotor to flying speed. On the instrument board is a table for the pilot's guidance, figures in r.p.m. are given for each tachometer. With left hand on the throttle, we read those figures. The engine picks up as it gets a little gas. The rotor tach trembles and its needle slides gradually around the dial.

Finally, when the engine is turning about 1400, the rotor tach hits 100 r.p.m. Looking up, we see the four blades cutting the air in a gleaming disc. Through the motor thunder rips the thin swish of airfoils. Instead of drooping as they did a moment ago, each blade now stands out with the ends a trifle above center. At this point it should be understood that they are not rigidly attached to the rotor hub. Instead, hinges form the connection and thereby give the whole structure a flexibility that, say engineers, is the secret of its strength.

The rotor is turning at the desired speed. We are ready to take off, but our tail is facing the wind. Swiftly, we do three things at once: one, release the rotor clutch and push the lever forward until the gear is entirely disengaged; two, shove the throttle to full speed; three, release one foot brake and kick the rudder toward the locked wheel.

The bus pivots as prop blast blows her tail around. Now her nose is in the wind. Quick! Release the other brake and let her roll.

The motor thunders full out. The rotor swishes about at 100 to 120 r.p.m. Forward stick digs the tailskid out of the turf. It is just like an airplane take-off. The only difference is the fan overhead. One wants to duck at first, but that feeling wears off.

We're galloping now! Ten yards, twenty yards, thirty—I haul back on the stick. Wheels spurn the soil and we are off—after a thirty-yard run!

What a climb. The nose streaks up and the big windmill tilts. An inclinometer is fastened to the side of your cockpit. Keep an eye on it. It tells an amazing story. More back stick. The steel ball in the inclinometer tube rolls to the ten-degree mark. That angle would stall most ships. It hits the fifteen-degree notch, and a look overside shows the earth dropping away like a lost world. But that isn't the end. More back stick lifts the nose again. Watch the little steel ball. Eighteen, nineteen, twenty degrees! That inclination would stall any commercial, army, or navy job in America. The autogiro climbs on.

We level off at 2000 feet and ease up the throttle. The flying field drops behind and we wing over open country. A speed test doesn't interest us; any airplane will go fast. We are exploring this one's capacity to do things that the ordinary ship cannot do. Slow flight, for instance.

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We can imagine that a fog is shutting down on us. Fog is one element a pilot cannot conquer. Yes, given a radio compass, sonic altimeters, and \$10,000 worth of blind flying instruments and equipment, he can take his transport plane through thick weather, but just now we are ordinary air tramps who are flying for the fun of it. We have good instruments but nothing special. Seeing that fog, sane birdmen would hunt a nest. But we can jog merrily along, with no more danger than would be encountered by a motorist who rides into the night.

Slow flight! Dream of the ages. Goal of every aeronautical engineer!

Get a good grip on your seat. We are going to fly backwards, tail first. Yup, the autogiro does that, too.

Here is how! We come across the field at about 2000 feet elevation. The wind is blowing fairly fresh making it a good spot for a demonstration. I cut the gun and lift the nose of the ship as the prop blast vanishes. For a long moment, the only sound is the swishing of the rotor blades. We sight along the edge of an aileron at the earth and notice that we are moving toward the opposite side of the field. But as we look, our forward speed stops and we begin to back up! Yes sir, we are doing just that; flying backwards in relation to the earth. You will also notice that all controls have the same customary feeling as when we were flying at 125 m.p.h.

It seems incredible but the whole secret lies in the action of the rotor. Fanning constantly, it produces a downward wash vigorous enough to give the control surfaces a grip on the air regardless of the ship's position or forward speed.

Of course we lose height—but very slowly. Backward, wind-driven, we recross the field. Giving it the gun we

climb through a fast dash, and cut it again. That is one thing that an ordinary airplane won't do.

Let us clear up one point right now. Does the rotor turn when the motor is dead? It does! It turns for the same reason that a windmill turns in the breeze. It turns every moment the ship is in the air for the reason that the least movement creates the breeze to drive its blades. After it is set in motion on the ground, with both wheels locked as before described, it is not connected to the motor. From take-off to set-down, it spins of its own free will.

The ship will land in any place that is large enough to hold it in perfect condition, and without any more jar than a Ford running across a street-car track at twenty miles per hour.

Now notice how we land. As we again arrive over the field I cut the gun and hold the nose down just enough to keep the wind from pushing us backward and we settle down at only fourteen feet per second. A slight jar tells us that we have landed.

"How about this ship for the average man?" people are asking, "Is it one that a dub can fly and live afterwards?"

Right now, as you read this, important brains are asking themselves that very question. Frankly, the autogiro has tossed a monkey wrench into the wheels of a lot of aero concerns.

No autogiro will ever replace the fast pursuit ship that breezes along at 250 m.p.h. But for the business man who wants speed with safety, the autogiro is the ship. It will enable him to take off from his own back yard and land on the roof of his office.

When the late Thomas Edison saw this ship land almost vertically at the Newark airport, he threw up his hands and said, "This is the airplane we have been waiting for."

And now for a more technical discussion on why the autogiro flies.

You know that an airfoil set at a certain angle of incidence and moving through air at a certain speed causes a vacuum to form above and a pressure below, which produces on that airfoil a force that we call lift. Take airplane wings, for instance. When moving forty or so miles an hour, they have enough vacuum above and pressure below to lift them off the ground. When their speed drops below the forty or so figure, they fall.

Our windmill, or rotor, consists of four twenty-four foot blades that measure approximately two feet across at the tips. Actually, they are wings that revolve about a common center.

Each of these four vanes is an airfoil the same as any airplane wing. When it moves through the air at a certain speed, it acquires this mysterious lift that makes things fly. Now visualize these blades whirling at 100 or 110 r.p.m. That speed plus a twenty-five m.p.h. forward speed, which is acquired as in any other plane by a conventionally mounted engine and prop, is sufficient to give them enough lift to hop the whole ship into the air.

All this lift, which comes chiefly at and near the ends of the revolving blades, one thinks, would cause a great deal of strain on the hub connections. Given a steel tube

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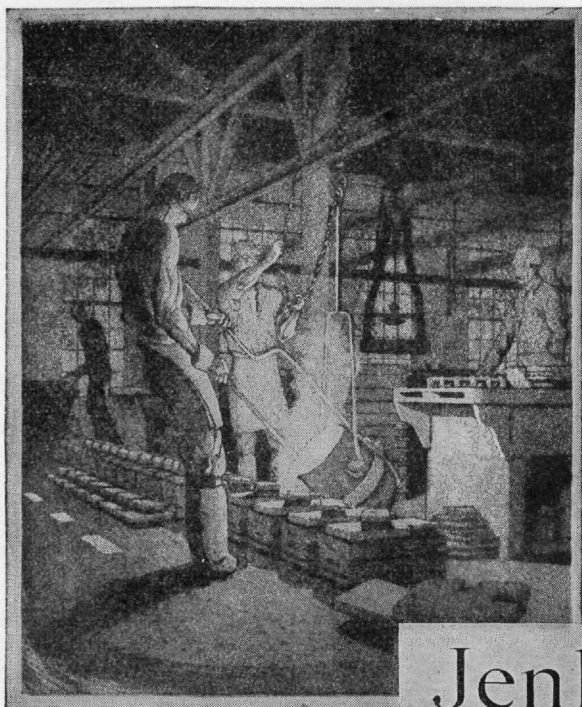
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that is fastened down at one end and raised at the other, one would think the fastened end would tear loose or the tube would crumple. This might occur if it were not for that quantity that engineers call centrifugal force.

When a thing revolves, centrifugal force is produced. Now this windmill of ours whirls at 100 r.p.m., and the force produced is about 5000 pounds. What happens? We have two forces, one lifting the ends of the vanes and the other pulling them apart. The result can be best illustrated by Cierva's own example. Suppose a span of this forty-eight foot windmill is represented by a piece of slack rope held horizontally. In the center it sags just a little, but when a pull is applied, say 500 pounds at each end, the center rises, because of the pull. That is what happens to our autogiro. The revolving vanes seek to straighten, due to centrifugal force, and the center rises, carrying fuselage, engine, and passengers. As the vanes' ends rise still higher because of the lift produced by their movement through the air, Old Man Centrifugal Force continues to keep the rope taut by tugging at the ends. And so the ship soars.

Which all goes to show that this autogiro is far more than just a curiosity or a scientific experiment. It is a new type of airplane that will revolutionize the aeronautical industry.
